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# WEEDING AS A STAND IMPROVEMENT MEASURE ON CUT-OVER SPRUCE LANDS

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For the past 25 years spruce forests of the Northeast have been subjected to extremely heavy cuttings. Such cuttings, often poorly timed and made without proper regard to reproduction conditions, have resulted in a slow but steady deterioration of formerly valuable spruce land. This deterioration takes the form of a gradual replacement of spruce, fir, and valuable hardwoods with less valuable and worthless species.

In general, recently cut-over spruce areas, regardless of severity of cutting, support enough valuable reproduction to insure satisfactory stands at maturity. Within a few years after cutting, however, myriads of hardwood stems of both desirable and inferior species take possession of such areas. These hardwoods make rapid height growth and soon overtop the slower growing spruce and fir, attaining a lead which they maintain for many years. Furthermore, the undesirable species often take the lead among the hardwoods. Under these conditions many valuable stems are crowded out or forced to assume subordinate positions in the stand. The most practical way to maintain a high proportion of desired species and to obtain optimum growth on areas cut 5 to 15 years ago is to undertake weeding - disengagement cuttings in which the undesirable species are killed or cut back.

## FACTORS INFLUENCING WEEDING PRACTICE

In the formulation of a weeding technic that will obtain most effective results, certain fundamental factors must be given consideration.

### Object of Management

In the spruce region, to which this discussion is restricted, the primary aim of management is usually the production of coniferous pulpwood species, mainly spruce and fir. These species form the backbone of the pulpwood industry in the Northeast and can be counted upon to maintain their value indefinitely. Thus, weeding operations will be so conducted as to favor the development of the softwood elements in the stand. On the stronger hardwood soils there will often be insufficient spruce and fir to produce a fully stocked stand at maturity. Under such conditions the better hardwood species, such as sugar maple, ash, and

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1/ Maintained at New Haven, Connecticut, in cooperation with Yale University.

birch should be favored also, with the object of developing a high quality, fully stocked mixed softwood-hardwood stand. 2/

Type

Cut-over lands in all spruce types can be improved by some form of weeding. However, in some types the need of weeding is greater than in others, the relative need being largely determined by the intensity of struggle between the desirable and undesirable species comprising the stand. Site conditions control to a marked degree the species, quantity, and rate of growth of the stand which springs up following cutting, and hence the degree of competition likely to obtain.

Broadly speaking there are three main types in the spruce region, and these constitute a natural classification in respect to the need for weeding:

(1) Strong softwood types.--Spruce slope type, spruce swamp type, and the poorly drained areas in the spruce flat type.

(2) Light softwood types.--Red spruce-sugar maple-beech type and the best sites in the yellow birch-red spruce type.

(3) Medium softwood types.--Bulk of the yellow birch-red spruce type, and best sites in the spruce flat and the lower spruce slope types.

Strong softwood types are characterized by relatively shallow, poorly drained soils conducive to the production of conifers and generally including relatively small numbers of hardwoods. Table 1 shows that these types have a preponderance of spruce and fir reproduction, representation of these species on 10-year-old cuttings approximating 75 percent. That there is a tendency toward increased representation of conifer reproduction as the stands grow older is evidenced by the figures shown for 15-year-old cuttings, where conifers are represented to the extent of about 80 percent. Spruce and fir, possessing the ability to thrive in wet soils, enjoy a natural advantage over the hardwoods which occur on these sites, consisting largely of paper birch, poplar, yellow birch, and red maple.

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2/ For methods of weeding in hardwoods see "Suggestions for Weeding in Northern Hardwoods" by Victor S. Jensen. Occasional Paper No. 3, Northeastern Forest Experiment Station, May 1935.

TABLE 1

Relation of Composition and Quantity of all Stems to Age of Cut-over Area 1/ for Two Types

Strong Softwood Types

| Age | Conifers | | Commercial Hardwoods | | Weed Species | | Total | Basis Plots |
|---|---|---|---|---|---|---|---|---|
| Years | Number | Percent | Number | Percent | Number | Percent | Number | Number |
| 10 | 3,537 | 75.4 | 931 | 19.9 | 222 | 4.7 | 4,690 | 46 |
| 15 | 3,716 | 80.8 | 862 | 18.7 | 22 | .5 | 4,600 | 14 |

Light Softwood Types

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | 2,196 | 34.1 | 3,350 | 52.1 | 890 | 13.8 | 6,436 | 53 |
| 15 | 1,503 | 24.4 | 3,273 | 53.0 | 1,396 | 22.6 | 6,172 | 20 |

On some of these lands spruce and fir will ultimately gain dominance without the assistance of weeding operations, but not without considerable retardation in growth rate due to the long period of suppression and loss in stocking from reduction in numbers. Here one weeding operation about the eighth year after cutting will suffice.

Light softwood types occur where there is good drainage combined with soils of depth and fertility, conditions which favor the production of large numbers of hardwoods, often to the exclusion of softwoods. On the 10-year-old cuttings analyzed in Table 1 hardwoods comprise about 66 percent of the stand. Their aggressiveness is indicated by an increase to nearly 76 percent in the 15-year-old cuttings.

In these types, once it succeeds in establishing itself, spruce attains its best development, but weeding is needed to prevent the elimination of large numbers of conifers by the more rapidly developing hardwoods. Because of the extremely favorable conditions for hardwood growth, weedings must be undertaken at a relatively early period - 5 to 7 years after logging. Second and even third weedings, spaced at 4 - to 5-year intervals, may be necessary to give ultimate dominance to the softwoods.

1/ Based on 1/8-acre plots.

Conditions in medium softwood types are intermediate between those in the two classes already described. Much of the growth consists of the light-foliaged species, such as paper and yellow birch, although red maple is a frequent component of the stand. Softwoods are ordinarily present in sufficient numbers to produce fully stocked stands. The soils, however, are of good enough quality to encourage the growth of hardwoods. The medium softwood types respond admirably to weeding operations. Competition between hardwoods and softwoods is more severe here than on the strong softwood types, but much less severe than on the light softwood types. If left unattended, hardwoods in these types generally gain the ascendency. Usually one weeding, approximately 8 to 10 years after cutting, suffices to place the softwoods in permanent possession of the area, though occasionally a second weeding is required.

Composition

The species making up the competing growth also influence the time and frequency of the weeding. Where tolerant spruce and fir occur in mixture with the comparatively intolerant birches, pin cherry, and aspen, which grow rapidly and have relatively light foliage, the softwoods maintain themselves fairly well. Early weeding under these conditions is not required, nor is there generally need for more than one weeding.

On the other hand, where spruce and fir grow in mixture with such hardwoods as beech, sugar maple, and red maple, which have very dense foliage and which are themselves extremely tolerant, competition is most keen and weeding becomes a matter of prime importance.

Height of Reproduction

A factor which must be given due weight in weeding operations on spruce cut-over lands is the relative heights of the crop and weed trees. Studies of height growth of spruce and fir show that reproduction ranging between 2 and 5 feet in height at the time of cutting makes the most rapid height growth thereafter (Fig. 1). Under favorable site conditions the advantage which spruce and fir advance growth in this height class possesses over new hardwoods springing up after cutting may suffice to maintain it as the dominant element for several years without the aid of weeding and may even obviate the need of any weeding whatsoever. On the other hand, where conifers spring up simultaneously with undesirable hardwoods, the latter soon outstrip the former and the conifers are often completely crowded out of the stand unless an early weeding is resorted to. Figure 1 shows that hardwood overtop their 6-inch spruce associates the second year following cutting. On the other hand, it is ordinarily 11 years before seedling hardwoods attain the height of spruce having the benefit of 5 feet of initial height at the time of cutting. Plainly, weeding must be undertaken earlier on cuttings where the crop trees to be released consist of small seedlings than where they are several feet in height.

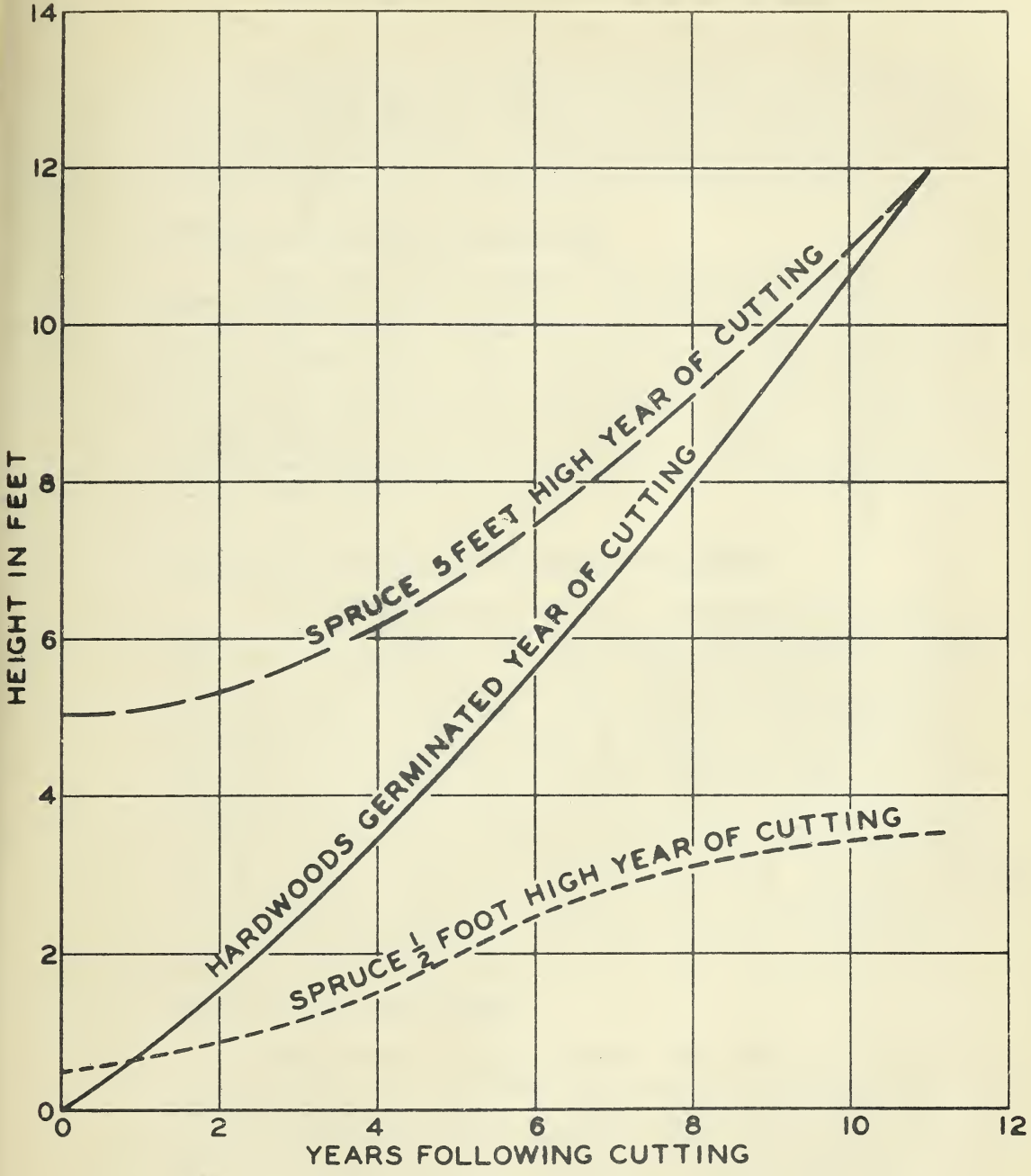


FIG. 1. COMPARATIVE GROWTH OF SEEDLINGS OF DIFFERENT SIZES FOLLOWING CUTTING

## APPLICATION OF WEEDING OPERATIONS TO STAND CONDITIONS

Because of the fact that cutting has been in progress over a long period in the spruce region, many areas have passed the stage where weeding will yield satisfactory returns. Spruce lands should, therefore, be classified on the basis of the relative benefit to be expected from weeding as follows:

### Stands in Profitable Weeding Stage

Under this classification come stands which are at the most favorable age for weeding. In general they comprise areas in the light softwood types cut 5 to 8 years ago; areas in the medium softwood types cut 8 to 10 years ago, and areas in strong softwood types cut 8 to 12 years ago. Such stands should be given first consideration; they represent the age at which weeding accomplishes most effective results. Delay in treatment of such areas results in stand deterioration and increased weeding costs, hence diminished returns.

### Stands Past the Most Profitable Weeding Stage

Under this classification fall extensive areas which have passed the period at which weeding could have been accomplished at a minimum cost. Roughly they comprise areas which were cut longer than 10 years ago. Here crop trees varying from seedlings to saplings 8 to 10 feet tall are overtopped and oppressed by a dense growth of hardwoods 1 to 3 inches in diameter and 8 to 15 feet in height. However, under the moderate competition of the less densely foliaged species, the suppressed conifers may persist for many years, and even on areas logged 15 to 20 years ago weeding would undoubtedly benefit them and save many of them from ultimate extinction. The cost of this release would be high but probably could be accomplished at less expense than planting, which ultimately might be necessary to keep the land productive.

### Stands too Old for Weeding

This classification includes older cuttings where hardwood species, having attained diameters up to 4 inches and heights of 15 feet or more, form a complete overstory and where many of the softwoods and valuable hardwoods which might have been saved by early weeding have been eliminated or badly suppressed. Removal of this overstory to benefit the softwoods would constitute a release cutting rather than a weeding. Such release cuttings in pole stands may be justified where a good stocking of softwoods exists or where a market is available for fuelwood to defray part or all of the costs of the operation.

## TIME TO UNDERTAKE WEEDING

Proper timing is of utmost importance if maximum returns on money invested are to be realized. If weeding is too long delayed high costs result because of the increased size of the stems to be cut. There is also a reduction in the vigor and capacity for quick recovery of the suppressed softwoods, a retardation in the growth rate of crop trees, and a reduction in stocking through loss of trees from prolonged suppression. In addition, more prolific, faster growing sprouts are produced by the larger hardwood stumps resulting from delayed weedings.

On the other hand, weeding can be undertaken too early, before dominance in crop trees has had an opportunity to express itself clearly. Too early weeding often results in the selection for crop trees of many individuals which later inspection proves should not have been liberated. Thus the stand derives but meager benefit from the treatment, and an outlay for a second weeding is necessary to rectify the errors of the first. Weeding should be delayed until it is possible to select with reasonable certainty the ultimate dominants of the favored species.

The proper time for weeding to be undertaken is when the overtopping trees begin to cause injury to prospective crop trees. An excellent gage as to the exact time in a particular stand is the degree of vigor of the crop trees and the rate at which they are growing. As long as most of the conifers are thrifty and are putting on height growth averaging 6 inches or more per year, there is no urgent need for weeding. When the trees show signs of failing vigor, as a lessening in the length and fading in the color of the needles, a thinning of the foliage, and a rapid diminution of terminal growth, weeding operations should no longer be delayed.

An important consideration, too, is proper timing with respect to season. In mixed spruce-hardwood types, late fall or winter months, when hardwood leaves have fallen, constitute the most favorable period for weeding, since spruce and fir, the favored species, can then be readily seen and the suitability of individuals for crop trees can be more accurately determined. Also, labor is more generally available in the winter months. However, in the spruce region there are long periods in the winter when weedings cannot be properly carried out on account of deep snow.

## WEEDING METHODS

For best results weeding should be done on a selective basis. Thus even in mixed spruce-hardwood types, where

spruce and fir only are considered the crop trees, broadcast weeding will seldom be practiced. Stands on areas in these types containing full stocking of spruce and fir may be regarded as consisting of but two elements: crop species - spruce and fir; and secondary species - mainly northern hardwoods. In weeding such stands the aim should be to develop a proper relationship between the two elements, using the inferior species as trainers in developing crop trees of high quality. This is best accomplished by cutting only such trees as is necessary to give crop trees opportunity for free upward growth. Thus side branching of crop trees is reduced to a minimum and natural pruning hastened. It is better to weed lightly, repeating the operation until the crop trees are secure, than to weed too heavily, creating low-quality stems and unproductive spots in the stand.

Growth of weed trees may be kept in check by either complete or partial severance of the stems at the base or at some point higher up. Which method to use depends largely on the relative heights of the crop and weed trees and the sprouting capacity of the latter. Lower topping or cutting will be required where crop trees are small. Where there is danger of prolific sprouting, as in the case of such species as red, mountain, and striped maple and pin cherry, partial severance of the stem is recommended as it discourages rapid growth of sprouts.

For release work in stems larger than 3 to 4 inches in diameter, girdling is equally as effective as cutting and is more economical unless a market exists for the material cut. Killing weed trees by poisoning represents still another effective method of ridding the stand of undesirable stems. Both girdling and poisoning possess the added advantage of producing no immediate slash, thus avoiding danger of accumulated slash smothering or deforming trees which should be released. In general, the menace to released trees from slash resulting from weeding is negligible in cuttings less than 12 years of age.

Tools

A wide variety of tools has been tried out in weeding and release work. The type to use depends largely on the size of the stems to be cut. Where the majority of the stems are larger than 2 inches in diameter, a light axe will prove the most serviceable tool. For stems between 1 and 2 inches in diameter the machete has proved to be generally satisfactory, along with meat cleavers, special brush hooks, and heavy knives. Stands with stems less than an inch in diameter, particularly if they contain species with easily broken wood, such as aspen, pin cherry, and mountain and striped maple, can be weeded by breaking stems with the hands. A recently developed tool which has proved useful for stems up to 2 inches in diameter is the improved type of clippers or pruning shears. For economic operation, tools should be kept in good cutting condition by frequent sharpening. This may be insured by providing each worker with a good quality pocket axe stone.

## Crew Organization

A properly organized crew is essential to effective conduct of weeding operations. Best results are obtained by crews of 2 or 3 men directed by an experienced foreman. The work should be so organized that the area to be treated will be covered systematically to avoid the necessity of reworking areas for spots which were skipped in the first operation. This can best be accomplished by working the crew back and forth on parallel strips under the guidance of the crew foreman, who works with his men.

## COSTS OF WEEDING OPERATIONS

Weeding costs vary considerably, depending on the age of the stand, its density, and composition. Thus the older stands with a dense stocking of large stems of species having dense wood, such as beech and maple, are the most costly to weed. Where the material cut is of cordwood size and can be marketed, the weeding operation may perhaps net the operator an immediate profit. Most operations, however, involve expenditures varying from 2 to 8 man-hours per weeding per acre. On this basis, where lands need two weedings,, 4 to 16 man-hours per acre are required, while 6 to 24 man-hours will be needed per acre on lands requiring 3 weedings. The expense incurred in weeding is generally worth while, as it should ultimately be more than covered by the increased quality and value of the final crop.

## THE FLUME BROOK WEEDING PLOTS

In October, 1927, a series of 3 quarter-acre plots were established on the White Mountain National Forest near Waterville, N.H., to determine the feasibility of converting a young mixed softwood-hardwood stand into an approximately pure spruce and fir stand through the weeding of the young hardwoods of both merchantable and unmerchantable species.

The plots were located in the Flume Brook watershed on a medium-softwood spruce site which had been clear cut 9 years previously for both hardwoods and softwoods. The plots at the time of establishment supported a dense stand of conifer and hardwood reproduction (Table 2). Conifers, chiefly spruce and fir, ranged from seedling size to 8 feet in height, the majority falling in the 2- and 3-foot height classes. Merchantable hardwood species, principally paper birch, yellow birch, and red maple, and worthless hardwoods, such as mountain ash, pin cherry, mountain holly, and serviceberry, already formed an overstory to the softwoods ranging 12 feet in height with the largest number of stems in the 6- and 8-foot height classes.

Two degrees of weeding were employed to determine their

relative advantages. One plot was held as a check, and the other two were weeded, one being given heavier treatment than the other. A heavy weeding would effect a greater initial reduction in competition, but there remained the possibility that light weeding, accomplished at half the cost, would be equally effective. If it did not, a second weeding was planned, to compare the relative merits of one heavy weeding as against two light weedings spaced at suitable intervals.

The lighter weeding was accomplished in 4 man-hours per acre, the other in 8. Analysis of stand tallies taken 5 years after treatment showed no significant difference between the heavily and lightly treated areas. The average of the two treated plots, therefore, was taken as the basis for comparison with the control plot in attempting to evaluate the effects of weeding.

TABLE 2

Composition and Quantity of Reproduction before and after Weeding

All Stems

| Year and Plot | Spruce and Fir | | Commercial Hardwoods | | Wood Species | | Total |
|---|---|---|---|---|---|---|---|
| | No. | Pct. | No. | Pct. | No. | Pct. | No. |
| 1928 | | | | | | | |
| Check | 4,650 | 40.0 | 4,950 | 42.6 | 2,025 | 17.4 | 11,625 |
| Treated | | | | | | | |
| Before weeding | 5,788 | 36.2 | 6,025 | 37.6 | 4,188 | 26.2 | 16,001 |
| After weeding | 5,738 | 48.8 | 3,012 | 25.4 | 3,064 | 25.8 | 11,864 |
| 1933 | | | | | | | |
| Check | 6,675 | 42.1 | 6,775 | 42.8 | 2,400 | 15.1 | 15,850 |
| Treated | 9,138 | 42.9 | 9,762 | 45.9 | 2,388 | 11.2 | 21,288 |

Stems 1-inch D.B.H. and Larger

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1928 | | | | | | | |
| Check | 75 | 4.0 | 1,525 | 81.3 | 275 | 14.7 | 1,875 |
| Treated | | | | | | | |
| Before weeding | 75 | 2.1 | 2,462 | 69.4 | 1,012 | 28.5 | 3,549 |
| After weeding | 75 | 3.8 | 1,326 | 68.0 | 548 | 28.1 | 1,949 |
| 1933 | | | | | | | |
| Check | 475 | 14.3 | 1,900 | 57.1 | 950 | 28.6 | 3,325 |
| Treated | 625 | 20.5 | 1,738 | 57.0 | 688 | 22.5 | 3,051 |

On an acre basis, weeding of 3,012 hardwoods and 1,124 weed trees per acre resulted in the release of an average of 1,490 conifers (Table 3). Even after weeding, however, the treated plots showed total numbers of stems slightly in excess of those on the check plot. Removal of the hardwoods had the effect of raising the representation of conifers from 36.2 percent to 48.8 percent (Table 2). Considering only dominant conifers (1 inch d.b.h. and above), representation of this class was nearly doubled, rising as it did from 2.1 percent to 3.8 percent. The increase in number of dominant conifers is of highest importance, for this class can be counted on to compete successfully with young hardwoods and brush growth.

The influence on the composition of the stand of 5 years elapsed time since treatment was determined from tallies made of the plots in 1932.

TABLE 3

Number of Trees Weeded and Crop Trees Released Per Acre

| Character of Weeding | Conifers Released | Species Weeded: Commercial Hardwoods | Species Weeded: Weed Hardwoods | Species Weeded: Total Hardwoods | Man-Hours of Labor |
|---|---|---|---|---|---|
| | Number | Number | Number | Number | Number |
| Heavy | 1,848 | 3,380 | 1,604 | 4,984 | 8 |
| Medium | 1,132 | 2,644 | 644 | 3,288 | 4 |
| Average | 1,490 | 3,012 | 1,124 | 4,136 | 6 |

A decided increase of both hardwoods and softwoods occurred on all plots, with the increase most pronounced on the treated areas. Of interest is the fact that the total number of weed hardwoods showed an increase only on the control area. On the treated area they registered a loss of nearly 700 stems per acre (Table 2), indicating that weeding had been effective in keeping weed hardwoods under control. The effect of weeding is also evidenced by the fact that the number of weed species in the larger sizes (stems larger than 1 inch d.b.h.) increased much less on the treated than on the control plot. Cutting back commercial hardwood induced prolific sprouting in these species, as evidenced by the decidedly greater gain in their number on the treated area - 3,012 to 9,762 - as compared to that on the untreated area where the number rose only from 4,950 to 6,775.

Although the actual gain in softwoods over the 5-year period amounted to 3,350 on the treated plot, an actual reduction of about 6 percent in their proportion (Table 2) occurred, owing to prolific sprouting of hardwoods whose increase

over the same period was twice that of the softwoods. On the control plot, softwoods increased to the extent of only 2,025, and the increase in hardwoods was much less than on the treated plot (1,875 as against 6,750), which resulted in a 2.1-percent rise in softwood representation. Of more interest, however, is the greater gain in dominant softwood stems (1 inch d.b.h. and larger) on the treated plot over that on the untreated plot. On both the treated and untreated plots dominant softwood stems averaged 75 per acre at the time the plots were established. Five years later the treated plots showed a total of 625 stems of this size class per acre as against 475 on the control plot.

It is still too early to judge the ultimate value of the weeding in this experiment. The moderate weeding has proved practically as effective as the heavier cutting. The treatment to date has had the worthwhile effect of increasing softwood representation and of providing a greater increase in the number of desirable dominant trees on the treated area. The continued aggressiveness shown by the hardwoods indicates the desirability of a second weeding.

## CONCLUSION

Cut-over spruce stands can be materially aided through weeding operations designed to liberate valuable spruce and fir reproduction from destructive competition of faster growing hardwoods and worthless species. Weeding is an effective measure for halting deterioration and obtaining fully stocked stands of valuable species. It is far cheaper to entail the low initial weeding expense necessary to save valuable reproduction already established than it is to tie up money in expensive planting in an effort to restock depleted areas. In numerous instances one weeding alone will suffice to change a young stand on the way to domination by worthless hardwoods to one of high quality and value. In carrying out weeding operations, as full a knowledge as possible of all factors determining areas needing treatment and the proper timing, the severity, and the frequency of the operations should be brought into play.